Lat 39.10178 Lon -120.63735

Forest Health Protection
Pacific Southwest Region

Date: February 2, 2011

File Code: 3420

To: District Ranger, American River RD, Tahoe National Forest

Subject: Insect and Disease Evaluation of the Deadwood Project and stands for silvicultural certification of Kelly Pavlica (FHP Report #NE10-13)

On August 12, 2010 at the request of Kelly Pavlica, Silviculturist, American River RD, Danny Cluck, Forest Health Protection (FHP) Entomologist, and Bill Woodruff, FHP Plant Pathologist, evaluated three forest stands within the Deadwood Project area which Ms. Pavlica is considering for her silvicultural certification stand and one stand the District hopes to underburn. Ms. Pavlica and Katie Crews, District NEPA Planner, accompanied us to the field. The objectives of this evaluation are to provide insect and disease information to help Ms. Pavlica select a suitable stand for her silvicultural certification. This evaluation also discusses the current forest health conditions in the stands and the influence these conditions would have on stand management objectives and provide recommendations as appropriate.

Sites evaluated: Deadwood Project (T14 and 15N; R11 and 12E, Mt. Diablo Meridian)

Site 1.
This stand (#5, from District records) is mixed conifer and adjacent to the Forest Hill Seed Orchard. The overstory is stocked mostly with large ponderosa pine (*Pinus ponderosa*) with lesser numbers of white fir (*Abies concolor*), incense cedar (*Calocedrus decurrens*) and Douglasfir (*Pseudotsuga menziesii*). The largest trees are approximately 36" dbh and 140' in height. The understory is black oak (*Quercus kelloggii*), white fir, incense cedar, Douglas fir and madrone (*Arbutus menziesii*). Old dead manzanita (*Arctostaphylos sp.)* "skeletons" (Fig. ?) are present on the forest floor. White fir dwarf mistletoe (*Arceuthobium abietinum f.sp. concolor)* is lightly infecting the overstory and understory white fir. Scattered large white fir snags are present in parts of the stand. Much diversity is present in both species composition and stand structure.

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The mortality observed in the overstory indicates this stand was at one time and possibly still is overstocked. Much understory vegetation was recently mechanically removed from some locations in Stand #5. However some of the stand remains overstocked. The overstocked areas could benefit by removing competing trees, mostly from the understory. Dwarf mistletoe infected trees and those with other defects should be removed first, unless they are needed to achieve management objectives. Since no heterobasidion root disease was found, all freshly cut conifer stumps over 14" stump diameter should be treated with a registered borate compound to prevent infection by *Heterobasidion spp*., the cause of heterobasidion root disease. Leaving the stumps untreated would probably result in infecting healthy roots and causing tree mortality for 30 years or more. The best control for this disease is prevention achieved by treating stumps.

Site 2.

We drove by some stands in the Deadwood Project that were planted after the Volcano Fire . Many Volcano ponderosa pine plantations are overstocked with small diameter sawtimber. Please refer to the attached FHP Report NE10-07, "Evaluation of western pine beetle activity in the Elliot Ranch plantation" for discussions and recommendations for ponderosa pine plantations in this area.

Site 3.

This stand (#52, from District records) appears to be a true white fir stand that historically regenerated every 50 – 100 years after each successive stand replacing wildfire. Heterobasidion root disease caused by *Heterobasidion occidentale* (formerly, S-type *H. annosum*) is present, possibly scattered throughout the stand. Fir engraver (*Scolytis ventralis*) mortality exists in much of stand #52. Pine stumps and young pine trees on the upper ridge and a couple large ponderosa pine in the lower drainage indicate that pine grows well in parts of stand #52. In addition, a few incense cedar and sugar pine (*P. lambertiana*) are present. The variety of trees present offers a challenge in selecting the best management to achieve a desired future condition.

The overstory in stand #52 is almost 100% white fir ranging from 8" to 24" dbh. Scattered larger white fir trees are present. Ponderosa pine trees, probably planted several decades ago, are growing on the ridge along the access road. One white fir, estimated to be 60" dbh and 140' in height, was observed in the drainage. The presence of large decayed pine stumps, mostly near the ridge, indicates that pine trees were once a larger component.

Although the understory is composed mostly of white fir, a few pole-sized incense cedars and sugar pine are scattered in the understory. Black oak is present as small trees and sprouts in a few places. Cherry (*Prunus sp.*), whitethorn (*Ceanothus cordulatus*) and/or greenleaf manzanita (*Arctostaphylos patula*) are also present. Very light dwarf mistletoe infections were observed on a few white fir trees. White pine blister rust (*Cronartium ribicola*) was observed infecting an understory sugar pine. A few small brooms caused by incense cedar rust (*Gymnosporangium libocedri*) were observed on an understory incense cedar. Heterobasidion root disease has created openings in the stand. Judging by the brush and lack of snags in these openings, the *Heterobasidion* appears to have been present for decades.

The basal area of stand #52 ranges between 180 and 260 sq.ft. From rough estimates made during the exam, it appears that white fir mortality, caused by fir engraver (*Scolytus ventralis*), averages between 5% and 20% of the stems in parts of the stand (Figs. ?).

White fir mortality has increase over the past three years throughout northeastern California as a result of drier than normal conditions. For example, the Palmer Hydrological Drought Index (PHDI) for Sierra Cascade Division, which encompasses the Deadwood area, has registered moderate drought conditions each year for 2007 – 2009 (Table 1).

Table 1. Palmer Hydrological Drought Index (PHDI) 2007 - 2010, Water Year (Oct-Sept), California Division 2 (Sierra Cascade)

YEAR	PHDI*
2007	-2.64
2008	-2.71
2009	-2.52
2010	0.14

*PHDI values ranging from -2.00 to -2.99 are considered moderate drought conditions. Severe drought conditions range from -3.00 to -3.99 and extreme drought conditions are below -4.00.

White fir succumbing to fir engraver attacks are typically predisposed by other factors that compromise their health and vigor. In the Deadwood area, high stand density in some stands, prolonged drought and heterobasidion root disease are all contributing factors in declining tree health. White fir trees in stand #52 will remain susceptible to high levels of mortality until the current drought conditions subside. More top kill and additional whole tree mortality should be expected next summer due to fir engraver beetle attacks sustained in 2010. Since the area is receiving above normal precipitation this winter, some white fir may be able to replenish their defense systems and resist further attacks. Some trees will require more than one season with adequate moisture before they will fully recuperate their natural defenses, assuming they are free of disease.

Some of the observed mortality is caused by the insect and disease complex (interaction) of heterobasidion root disease and the fir engraver beetle, combined with the recent below average precipitation. Mortality from this complex is common in true fir stands in California. Earlier treatments in stand #52 removed almost all pine trees. This is unfortunate because pine trees are more drought tolerant than white fir. Fire exclusion over the past century has allowed high densities of white fir to establish in between the large pine that historically may have dominated the ridge-top forest. Fire exclusion may have prevented the remainder of stand #52 from regenerating in the last century, and removing aging overstocked fir that is now infected with *Heterobasidion*.

Any treatment which would result in returning stand #52 to its former condition with a higher percentage of pine would be desirable from a forest health prospective. This is because pine is more resilient to drought and fire than white fir. Also pine is resistant to *H. occidentale.*

In the event managers wish to control *Heterobasidion* root disease in stand #52, two options exist:

1. Removing all the white fir in the stand to achieve total control of *H. occidentale,* or
2. Removing only the white fir suspected of being infected.

For option #1, total control of *Heterobasidion* can only be achieved by removing all host trees. In effect, all the white fir would be removed from stand #52 and kept from reestablishing for at

least 30 years; which should be sufficient time for all the fir roots to completely decay, effectively killing all the *Heterobasidion*. In the place of white fir, non-host seedlings such as pine or incense cedar could be grown. Implementing option #1 would result in an even-aged stand with little structural diversity and no tree cover during the regeneration phase.

For option #2, all white fir would be removed from all suspected *Heterobasidion* centers using group selection. Pine or incense cedar seedlings would then be planted in the resulting openings. In the rest of the stand, the white fir would be thinned to the desired stocking by removing the slow-growing fir and trees with unwanted defects. Slow-growing white fir trees are usually those with short growth leaders. A short growth leader is usually caused by inter-tree competition, soil compaction and/or disease (including *H. occidentale*, dwarf mistletoe, etc.). In thinning stand #52, all pine and incense cedar and black oak could be retained to enhance heterogeneity. Sugar pine infected with white pine blister rust or incense cedar rust brooms, should be removed when the subsequent defects detract from the stand management objectives. Since it is impossible to know exactly which fir trees are infected with *H. occidentale*, option #2 will result in the leaving trees infected with *H. occidentale*. Being a disease that infects primarily the heartwood in fir, *Heterobasidion* infection in true fir is generally lethal only when an infected tree is stressed by drought and/or insects. Implementing option #2 would result in much structural and species diversity in stand #52 and continued tree cover.

Increasing the percentage of pine and incense cedar in the stand will increase the stand resilience to drought and possibly future climate change. It is not recommended to treat the fir stumps with borate since the chemical only prevents infection in healthy fir stumps. Borates do not control *Heterobasidion* infections already residing in the roots (more about borates follows on the next page).

Site 4.

This stand (#57, from District records) is not being considered by Ms. Pavlica as one to be used for her silvicultural certification. Instead, this stand is being considered for an underburn. Stand #57 is primarily widely spaced old growth sugar pine (30"+ dbh, 110'+ tall) and ponderosa or Jeffrey pine. One large sugar pine tree with red turpentine beetle (Dendroctonus brevicomis) pitch tubes on the bole appeared to be fading. Compaction from an old logging road a few feet from this dying tree may have stressed this tree by limiting the available soil moisture. No other tree mortality was observed. A dwarf mistletoe plant, *A. californicum*, was found growing on one 6-inch tall sugar pine seedling (Fig. ?)

If fire is introduced into stand #57 to reduced fuels and manage stocking in the understory unacceptable levels of mortality of the old growth pine may result. This mortality most often occurs as a direct result of cambium or crown injury to individual trees during the fire. Mature sugar pines are especially susceptible to lethal basal cambium injury from the heat that develops when the deep duff and litter that has accumulated at their bases is consumed. These duff mounds typically burn at a slow rate with lethal temperatures, causing severe injury to the cambium which girdles the trees. To protect individual high-value large diameter pine from lethal cambium injury, raking the duff away from their bases before burning (within 24" of the bole and down to mineral soil) is recommended.

Additional Discussion and Recommendations

As previously stated, stand #5 and the Volcano plantation stands would probably be poor ones for silvicultural certification because they lack management complexity. However, stand #52 has several insect and disease issues, structural diversity and a potential for species diversity which offer several management options.

Insect and disease caused tree mortality is occurring at elevated levels within Stand #52. Leaving this stand untreated would probably result in an elevated level of fir mortality, especially during periods of below normal precipitation.

Any thinning alternative being considered for stand #52 should follow past direction from the Regional Forester to thin to "ensure that density does not exceed an upper limit (for example: 90% of normal basal area, or 60% of maximum stand density index)" and to "design thinnings to ensure that this level will not be reached again for at least 20 years after thinning." (Regional Forester letter, "Conifer Forest Density Management for Multiple Objectives", July 14, 2004).

Management could emphasize variability in stand #52 by incorporating unthinned leave groups, pine restoration areas, and structural thinning (as opposed to a strict thin from below or a fixed-spacing thin). Drought tolerant species such as ponderosa and sugar pine, black oak and incense cedar should be retained over white fir to help increase their relative numbers within the stand and increase overall species diversity. Preference for removal will be given to diseased trees and trees infested with bark beetles, except where retention of these will conflict with management objectives. Structural thinning can be accomplished by removing all white fir from *Heterobasidion* centers; creating openings that can be planted with non-host species such as ponderosa pine and rust-resistant sugar pine.

Borate discussion: For all treatments on the Tahoe NF, it is recommended that a registered borate compound be applied to stumps of all freshly cut pine with stump diameters greater than14". The two borates registered for treating stumps in California are Sporax®, applied in granular form, and Cellu-Treat®, applied as a liquid. Treating true fir stumps over the entire Deadwood project area with borate is not recommended because fir type *Heterobasidion* root disease is already present in much of the white fir. Note: Stump treatment with borates only prevents *H. occidentale* from infecting healthy roots; it does not cure the disease. In situations where a stand of white fir trees appears healthy before treatment (ie. there is good evidence that *H. occidentale* is not present in the roots), it is recommended to treat freshly cut stumps to prevent the pervasive fungal spores from infecting the stump and roots of healthy trees. Once *Heterobasidion* spp. becomes established in the roots of a true fir, it can continue to grow and spread to adjacent conifers or shrubs indefinitely or until all the available wood in the roots and butts is dead and decayed.

Climate Change: Predicted climate change is likely to impact trees growing in the Dogwood Project area over the next 100 years. Although no Tahoe National Forest specific climate change models are available at this time, there is a general consensus among California models that summers will be drier than they are currently. This prediction is based on the forecasted rise in mean minimum and maximum temperatures and remains consistent regardless of future levels of annual precipitation (C. Mallek and H. Safford, *A summary of current trends and probable future trends in climate and climate driven processes in the Eldorado and Tahoe National Forests and the neighboring Sierra Nevada, unpublished report, 2010*). The risk of bark beetle caused tree mortality will likely increase for all conifer species under this scenario, especially drought

intolerant white fir. Improving the resilience of stands to future disturbance events through density, size class and species composition management will be critical to maintaining a healthy forested landscape.

If you have any questions regarding this report and/or need additional information please contact Danny Cluck at 530-252-6431 or Bill Woodruff at 530-252-6680.

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Insect and Disease Information

Western Pine Beetle

The western pine beetle, *Dendroctonus brevicomis*, has been intensively studied and has proven to be an important factor in the ecology and management of ponderosa pine throughout the range of this host species (Miller and Keen 1960). This insect breeds in the main bole of living ponderosa pine larger than about 8 inches dbh. Normally it breeds in trees weakened by drought, overstocking, root disease, dwarf mistletoe or fire. Adult beetles emerge and attack trees continuously from spring through fall. Depending on the latitude and elevation, there can be from one to four generations per year.

Evidence of Attack

Initial attacks are made about mid-bole and subsequent attacks fill in above and below. Pitch tubes are formed on the tree trunk around the entry holes. The pitch tubes are red-brown masses of resin and boring dust. Relatively few, widely scattered, white pitch tubes usually indicate that the attacks were not successful and that the tree should survive. Pheromones released during a successful attack attract other western pine beetles. Attacking beetles may spill over into nearby apparently healthy trees and overwhelm them by sheer numbers.

Life Stages and Development

These beetles pass through the egg, larval, pupal and adult stages during a life-cycle that varies in length dependent primarily upon temperature. Adults bore a sinuous gallery pattern in the phloem and the female lays eggs in niches along the sides of the gallery. The larvae are small white grubs that first feed in the phloem and then mine into the middle bark where they complete most of their development. Bluestain fungi, introduced during successful attacks, contribute to the rapid tree mortality associated with bark beetle attacks.

Conditions Affecting Outbreaks

Outbreaks of western pine beetle have been observed, and surveys made, in pine regions of the West since 1899 (Hopkins 1899; cited in Miller and Keen 1960). An insect survey completed in 1917 in northern California indicated that over 25 million board feet of pine timber had been killed by bark beetles. Information from surveys initiated in the 1930s indicates that there were enormous losses attributed to western pine beetle around that time. During the 1930's outbreak, most of the mortality occurred in stands of mature or overmature trees of poor vigor (Miller and Keen 1960). Group kills do not typically continue to increase in size through successive beetle generations as is typical with Jeffrey pine beetle. Rather, observations indicate that emerging beetles tend to leave the group kill area to initiate new attacks elsewhere.

The availability of suitable host material is a key condition influencing western pine beetle outbreaks. In northeastern California, drought stress may be the key condition influencing outbreaks. When healthy trees undergo a sudden and severe moisture stress populations of western pine beetle are likely to increase. Healthy trees ordinarily produce abundant amounts of resin, which pitch out attacking beetles, but when deprived of moisture, stressed trees cannot produce sufficient resin flow to resist attack. Any condition that results in excessive demand for moisture, such as tree crowding, competing vegetation or protracted drought periods; or any condition that reduces that ability of the roots to supply water to the tree, such as mechanical damage, root disease, or soil compaction, can cause moisture stress and increase susceptibility to attack by the western pine beetle. Woodpeckers and predaceous beetles are natural control agents when beetle populations are low.

Mountain pine beetle

The mountain pine beetle, *Dendroctonus ponderosae*, attacks the bole of ponderosa, lodgepole, sugar and western white pines larger than about 8 inches dbh. Extensive infestations have occurred in mature lodgepole pine forests. Group killing often occurs in mature forests and young overstocked stands of ponderosa, sugar and western white pines.

Evidence of Attack

The first sign of beetle-caused mortality is generally discolored foliage. The mountain pine beetle begins attacking most pine species on the lower 15 feet of the bole. Examination of infested trees usually reveals the presence of pitch tubes. Pitch tubes on successfully infested trees are pink to dark red masses of resin mixed with boring dust. Creamy, white pitch tubes indicate that the tree was able to "pitch out" the beetle and the attack was not successful. In addition to pitch tubes, successfully infested trees will have dry boring dust in the bark crevices and around the base of the tree. Attacking beetles carry the spores of blue-staining fungi which develop and spread throughout the sapwood interrupting the flow of water to the crown. The fungi also reduces the flow of pitch in the tree, thus aiding the beetles in overcoming the tree. The combined action of both beetles and fungi causes the needles to discolor and the tree to die.

Life Stages and Development

The beetle develops through four stages: egg, larva, pupa and adult. The life cycle of the mountain pine beetle varies considerably over its range. One generation per year is typical, with attacks occurring from late June through August. Two generations per year may develop in low elevation sugar pine. Females making their first attacks release aggregating pheromones. These pheromones attract males and other females until a mass attack overcomes the tree. The adults bore long, vertical, egg galleries and lay eggs in niches along the sides of the gallery. The larvae feed in mines perpendicular to the main gallery and construct small pupal cells at the end of these mines where they pupate and transform into adults.

Conditions Affecting Outbreaks

The food supply regulates populations of the beetle. In lodgepole pine, it appears that the beetles select larger trees with thick phloem, however the relationship between beetle populations and phloem thickness in other hosts has not been established. A copious pitch flow from the pines can prevent successful attack. The number of beetles, the characteristics of the tree, and the weather affect the tree's ability to produce enough resin to resist attack. Other factors affecting the abundance of the mountain pine beetle include nematodes, woodpeckers, and predaceous and parasitic insects. As stand susceptibility to the beetle increases because of age, overstocking, diseases or drought, the effectiveness of natural control decreases and pine mortality increases.

Fir Engraver

The fir engraver attacks red and white fir in California. Fir engraver adults and developing broods kill true firs by mining the cambium, phloem, and outer sapwood of the bole, thereby girdling the tree. Trees greater that 4" in diameter are attacked and often killed in a single season. Many trees, weakened through successive attacks, die slowly over a period of years. Others may survive attack as evidenced by old spike-topped fir and trees with individual branch mortality. Although many other species of bark beetles cannot develop successful broods without killing the tree, the fir engraver beetle is able to attack and establish broods when only a portion of the cambium area has been killed.

Evidence of Attack

Fir engravers bore entrance holes along the main stem, usually in areas that are > 4" in diameter. Reddish-brown or white boring dust may be seen along the trunk in bark crevices and in spider webs. Some pitch streamers may be indicative of fir engraver attacks; however, true firs are known to stream pitch for various reasons and there is not clear evidence that pitch streamers indicate subsequent tree mortality or successful attack. Resin canals and pockets in the cortex of the bark are part of the trees defense mechanism. Beetle galleries that contact these structures almost always fail to produce larval galleries as the adults invariably abandon the attack. Pitch tubes, often formed when bark beetles attack pine, are not produced on firs.

Adults excavate horizontal galleries that engrave the sapwood; the larval galleries extend at right angles along the grain. Attacks in the crown may girdle branches resulting in individual branch mortality or "flagging". Numerous attacks over part or the entire bole may kill the upper portion of the crown or the entire tree. A healthy tree can recover if sufficient areas of cambium remain and top-killed trees can produce new leaders. The fir engraver is frequently associated with the roundheaded fir borer and the fir flatheaded borer.

Life Stages and Development

In the summer, adults emerge and attack new host trees. The female enters the tree first followed by the male. Eggs are laid in niches on either side of the gallery. Adult beetles carry the brown staining fungi, *Trichosporium symbioticum*, into the tree that causes a yellowish-brown discoloration around the gallery. The larvae mine straight up and down, perpendicular to the egg gallery. Winter is commonly spent in the larval stage, with pupation occurring in early spring. In most locations, the fir engraver completes its life cycle in 1 year, however at higher elevations 2 years may be required.

Conditions Affecting Outbreaks

Fir engravers bore into any member of the host species on which they land but establish successful galleries only in those that have little or no resistance to attack. Populations of less aggressive species like fir engraver are likely to wax and wane in direct relationship to the stresses of their hosts. Drought conditions often result in widespread fir mortality; however, attempting to determine when outbreaks will occur is difficult. Lowered resistance of trees appears to be a contributing factor. Overstocking and the increased presence of fir on sites that were once occupied by pine species may also contribute to higher than normal levels of fir mortality. Several insect predators, parasites and woodpeckers are commonly associated with the fir engraver and may help in control of populations at endemic levels.

Heterobasidion Root Disease

Heterobasidion spp. is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. Madrone (*Arbutus menziesii*), and a few brush species (*Arctostaphylos spp.* and *Artemisia tridentata*) are occasional hosts. Other hardwood species are apparently not infected. The disease has been reported on all National Forests in California, with incidence particularly high on true fir in northern California, in the eastside pine type forests, and in southern California recreation areas.

Heterobasidion root disease is one of the most important conifer diseases in Region 5. Current estimates are that the disease infests about 2 million acres of commercial forestland in California, resulting in an annual volume loss of 19 million cubic feet. Other potential impacts of the disease include: increased susceptibility of infected trees to attack by bark beetles, mortality of infected trees presently on the site, the loss of the site for future production, and depletion of vegetative cover and increased probability of tree failure and hazard in recreation areas.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar. New infection centers are initiated when airborne spores produced by the conks land and grow on freshly cut stump surfaces. Infection in true fir may also occur through fire and mechanical wounds, or occasionally, through roots of stumps in the absence of surface colonization. From the infected stump surface, the fungus grows down into the roots and then spreads via root-to-root contact to adjacent live trees, resulting in the formation of large disease centers. These infection centers may continue to enlarge until they reach barriers, such as openings in the stand or groups of resistant plants. In pines, the fungus grows through root cambial tissue to the root crown where it girdles and kills the tree. In true fir and other non-resinous species, the fungus sometimes kills trees, but more frequently is confined to the heartwood and inner sapwood of the larger roots. It then eventually extends into the heartwood of the lower trunk and causes chronic decay and growth loss.

Heterobasidion root disease in western North America is caused by two species: *Heterobasidion occidentale* (also called the 'S' type) and *H. irregulare* (also called the 'P' type). These two species of *Heterobasidion* have major differences in host specificity. *H. irregulare* ('P' type) is pathogenic on ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense cedar, western juniper, pinyon, and manzanita. *H. occidentale* ('S' type) is pathogenic on true fir, spruce and giant sequoia. This host specificity is not apparent in isolates from stumps; with *H. occidentale* being recovered from both pine and true fir stumps. These data suggest that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for many years. Young conifers established near these stumps often die shortly after their roots contact infected roots in the soil.

Dwarf Mistletoe

Dwarf mistletoes (Arceuthobium spp.) are parasitic, flowering plants that can only survive on living conifers in the Pinaceae. They obtain most of their nutrients and all of their water and minerals from their hosts.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and fall from the aerial shoots. The seeds are forcibly discharged. The seed is covered with a sticky substance and adheres to whatever it contacts. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seeds is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occassionaly vectored by birds and animals.

Vertical spread within tree crowns of most dwarf mistletoes is limited to less than one foot per year because of foliage density. Because of the thin crowns of gray pine, however, the vertical rate of spread has been measured as being greater than 2 feet per year. This rate of spread equalled or exceeded the rate of height growth of infected trees.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow-green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings.

White pine blister rust

White pine blister rust is caused by Cronartium ribicola an obligate parasite that attacks 5-needled pines and several species of Ribes spp. The fungus needs the two alternate hosts to survive, spending part of its life on 5-needled pines and the other on Ribes spp. The disease occurs throughout the range of sugar pine to the southern Sierra Nevada, but has not been reported further south. Infection of pines results in cankers on branches and main stems, branch mortality, top kill, and tree mortality.

Spores (aeciospores) produced by the fungus in the spring on pine bole or branch cankers are wind-disseminated to Ribes spp. where they infect the leaves. Spores (urediospores) produced in orange pustules on the underside of the leaves reinfect other Ribes spp. throughout the summer, resulting in an intensification of the rust. A telial spore stage forms on Ribes spp. leaves in the fall. Teliospores germinate in place to produce spores (sporida) which are wind-disseminated to pines and infect current year needles. Following infection, the fungus grows from the needle into the branch and forms a canker. After 2 or 3 years, spores are produced on the cankers and are spread to Ribes spp. to continue the cycle. Although blister rust may spread hundreds of miles from pines to Ribes spp., its spread from Ribes spp. back to pines is usually limited to a few hundred feet.

Branch cankers continue to enlarge as the fungus invades additional tissues and moves toward the bole. Branch cankers within 24 inches of the bole will eventually form bole cankers. Bole cankers result in girdling and death of the tree above the canker. Cankers that have margins more than 24 inches from the main bole are unlikely to reach the bole and only branch flagging will result.

Forest Health Protection
Pacific Southwest Region

Date: July 15, 2010
File Code: 3420

To: District Ranger, American River Ranger District, Tahoe National Forest

Subject: Evaluation of western pine beetle activity in the Elliot Ranch plantation (FHP Report NE10-07)

At the request of Kelly Pavlica, Silviculturist, American River Ranger District, Tahoe National Forest, I conducted a field evaluation of proposed thinning treatment areas within the Elliot Ranch plantation on June 1, 2010. The objectives of the visit were to evaluate western pine beetle (*Dendroctonus brevicomis*) activity and stand conditions and to discuss treatment alternatives. Kelly Pavlica and Tony Rodarte accompanied me in the field.

Background

The Elliot Ranch ponderosa pine (*Pinus ponderosa*) plantation, established in 1950 after a wildfire, is located about 11 miles NE of Foresthill, CA at elevations ranging between 3800 and 4500 feet (approx. 39° 09' 12.4"N and 120° 45' 22.6"W). Annual precipitation is approximately 60 inches. Long-term management objectives for this plantation are to reduce stand density, increase tree species diversity and use prescribed fire to maintain desired fuel loadings.

Observations

Average density within most of the proposed treatment units is well above recommended levels that would reduce the risk of successful western pine beetle attacks in ponderosa pine stands. Data provided by the District shows that the average Stand Density Index (SDI) within the proposed treatment areas is 438 and the average basal area is 314 sq.ft./acre.

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Western pine beetle activity is high within this entire area as group killing of pole and sawtimber sized ponderosa pine is evident throughout the plantation. Most of this mortality has occurred over the past 2-3 years (Region 5 Aerial Detection Survey 2007-2009) but is continuing based the observation of green infested trees during this visit.

Discussion

High stand density combined with drought conditions cause extreme moisture stress in individual trees, thus reducing their ability to fend off bark beetle attacks. Healthy ponderosa pines defend themselves by producing resins that drown attacking beetles. When trees are stressed, resin pressure is reduced and the probability of successful bark beetle attack in increased. High stand density may also improve conditions for the bark beetle pheromone communication system, which facilitates mass attacks on individual trees, by concentrating the pheromone plume under a full canopy.

Bark beetle caused mortality has increased throughout California due in part to below normal precipitation experienced three of the past four years. Western pine beetle caused mortality of ponderosa pine has also increased in many areas with higher levels of mortality occurring in overstocked stands. Dense stands of even-aged ponderosa pine are especially susceptible to large group killing of trees during extended periods of below normal precipitation as was observed in the Elliot Ranch plantation. Even with the mortality that has occurred here over the past two to three years, stand densities are still extremely high and the potential exist for significantly more bark beetle caused mortality. For example, the current SDI level of 438 that exists within the proposed treatment areas is well above the limiting SDI of 365 for ponderosa pine. SDI 365 is considered the upper management zone above which bark beetle outbreaks are likely to occur (Oliver 1995).

The best strategy to decrease the amount of additional mortality in the immediate and long-term is to reduce stand density through thinning. Thinning will increase the health and vigor of residual ponderosa pines by reducing competition for limited soil moisture (Fettig et al. 2007). Opening up the canopy may also disrupt the pheromone communication system by creating convection currents and air turbulence through increases in soil temperature (Bartos and Amman 1989).

The District is proposing to reduce SDI within the Elliot Ranch treatment units to below 230. SDI 230 is the defined threshold for the zone of imminent bark beetle caused mortality. Within this zone, endemic populations kill a few trees but net growth is still positive (Oliver 1995). Thinning stands to this level will reduce the risk of additional bark beetle caused mortality by reducing tree competition for limited water and nutrients. Thinning to this level would also be consistent with past direction from the Regional Forester that suggests designing thinnings to "ensure that density does not exceed an upper limit (for example: 90% of normal basal area, or 60% of maximum stand density index)" and to "design thinnings to ensure that this level will not be reached again for at least 20 years after thinning." (Regional Forester letter, "Conifer Forest Density Management for Multiple Objectives", July 14, 2004).

This thinning project will be covered under the National Environmental Policy Act (NEPA) by Categorical Exclusion #14 [36 CFR 220.6(e)(14)] *Commercial and non-commercial sanitation harvest of trees to control insects or disease not to exceed 250 acres, requiring no more than ½ mile of temporary road construction, including removal of infested/infected trees and adjacent live uninfested/uninfected trees as determined necessary to control the spread of insects or disease*.

Based on my observations of the Elliot Ranch site, and the information provided within this evaluation, it is my opinion that this project meets the criteria outlined in this categorical exclusion.

If you have any questions regarding this report and/or need additional information please contact me at 530-252-6431.

/s/ Danny Cluck

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Citations:

Bartos, D.L., Amman, G.D., 1989. Microclimate: an Alternative to Tree Vigor as a Basis for Mountain Pine Beetle Infestations. RP-INT-400. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT, 10 pp.

Fettig, C.J.; Klepzig, K.D.; Billings, R.F.; Munson, A.S.; Nebeker, T.E.; Negrón, J.F.; Nowak, J.T. 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle outbreaks in coniferous forests of the western and southern United States. Forest Ecology and Management. 238: 24–53.

Oliver, W.W., 1995. Is self-thinning in ponderosa pine ruled by Dendroctonus bark beetles? In: Proceedings of the 1995 National Silviculture, Workshop, GTR-RM-267. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, C.O., pp., 213–218.

Western Pine Beetle Information

The western pine beetle, *Dendroctonus brevicomis*, has been intensively studied and has proven to be an important factor in the ecology and management of ponderosa pine throughout the range of this host species (Miller and Keen 1960). This insect breeds in the main bole of living ponderosa pine larger than about 8 inches dbh. Normally it breeds in trees weakened by drought, overstocking, root disease, dwarf mistletoe or fire. Adult beetles emerge and attack trees continuously from spring through fall. Depending on the latitude and elevation, there can be from one to four generations per year.

Evidence of Attack

Initial attacks are made about mid-bole and subsequent attacks fill in above and below. Pitch tubes are formed on the tree trunk around the entry holes. The pitch tubes are red-brown masses of resin and boring dust. Relatively few, widely scattered, white pitch tubes usually indicate that the attacks were not successful and that the tree should survive. Pheromones released during a successful attack attract other western pine beetles. Attacking beetles may spill over into nearby apparently healthy trees and overwhelm them by sheer numbers.

Life Stages and Development

These beetles pass through the egg, larval, pupal and adult stages during a life-cycle that varies in length dependent primarily upon temperature. Adults bore a sinuous gallery pattern in the phloem and the female lays eggs in niches along the sides of the gallery. The larvae are small white grubs that first feed in the phloem and then mine into the middle bark where they complete most of their development. Bluestain fungi, introduced during successful attacks, contribute to the rapid tree mortality associated with bark beetle attacks.

Conditions Affecting Outbreaks

Outbreaks of western pine beetle have been observed, and surveys made, in pine regions of the West since 1899 (Hopkins 1899; cited in Miller and Keen 1960). An insect survey completed in 1917 in northern California indicated that over 25 million board feet of pine timber had been killed by bark beetles. Information from surveys initiated in the 1930s indicates that there were enormous losses attributed to western pine beetle around that time. During the 1930's outbreak, most of the mortality occurred in stands of mature or overmature trees of poor vigor (Miller and Keen 1960). Group kills do not typically continue to increase in size through successive beetle generations as is typical with Jeffrey pine beetle. Rather, observations indicate that emerging beetles tend to leave the group kill area to initiate new attacks elsewhere.

The availability of suitable host material is a key condition influencing western pine beetle outbreaks. In northeastern California, drought stress may be the key condition influencing outbreaks. When healthy trees undergo a sudden and severe moisture stress populations of western pine beetle are likely to increase. Healthy trees ordinarily produce abundant amounts of resin, which pitch out attacking beetles, but when deprived of moisture, stressed trees cannot produce sufficient resin flow to resist attack. Any condition that results in excessive demand for moisture, such as tree crowding, competing vegetation or protracted drought periods; or any condition that reduces that ability of the roots to supply water to the tree, such as mechanical damage, root disease, or soil compaction, can cause moisture stress and increase susceptibility to attack by the western pine beetle. Woodpeckers and predaceous beetles are natural control agents when beetle populations are low.